International Journal of Finance, Insurance and Risk Management
Volume IX, Issue 1-2, 2019

pp. 94-123

An Analysis of Efficiency and Productivity Change in Microfinance Institutions in the European Union: A DEA-MPI Approach*

Submitted 15/03/19, 1st revision 21/04/19, 2nd revision 18/05/19 accepted 10/06/19

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Abstract:

Purpose: *Over the last few decades, microfinance institutions (MFIs) have been essential towards filling certain gaps in the financial sector, specifically in providing credit to low-income individuals who cannot gain credit access from conventional financial institutions. Ultimately, this reduces poverty and enhances the sustainability of society. However, in order to be able to fulfil this function, MFIs should themselves be financially sustainable, as evidenced from their recent shift in their main social objective towards commercialization and more market-based financial services. The main purpose of this study is to examine the sustainability of MFIs under the dual objective approach; that is, (i) whether they had enough outreach to serve their customers, and (ii) whether they are financially strong enough to cover their operating costs.*

Design/Methodology/Approach: *We applied a non-parametric approach and the Data Envelopment Analysis Program (DEAP), with the aid of the Malmquist Productivity Index (MPI) and were able to examine a number of productivity and efficiency changes of MFIs that occurred during the sampling period between 2013 and 2017. This exercise involved decomposing several significant components, which include technical efficiency, technological efficiency, pure efficiency and scale efficiency.*

Findings: *To be able to perform these dual objectives successfully in the long run, MFIs need to improve cost-effectiveness and productivity. This is where the need for efficiency and productivity analyses arises.*

Practical Implications/Originality/Value: *This study is intended to fill a gap in literature arising from a lack of studies that analyze efficiency and productivity changes occurring within MFIs in the European Union region. Such an analysis should ultimately help MFIs to be sustainable in the long term.*

Keywords: *Microfinance institutions; DEA; MPI; efficiency and productivity changes.*
JEL Codes: *G21.* ***Article type:*** *Research study.*

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**This paper is based on the unpublished thesis by Magri, A. (2018). An Analysis of Efficiency and Productivity change in Microfinance institutions in the European Union: A DEA-MPI approach, supervised by Dr. S. Grima.*

1. Introduction

One of the seventeen Sustainable Development Goals outlined by the United Nations is to eradicate poverty and for economic growth to be more inclusive in order to create sustainable jobs and promote equality by 2030 (United Nations, 2015). In this regard, microfinance institutions (MFIs) have been essential towards helping individuals with low income, who might not otherwise have access to typical banking services, to create or expand their businesses. In developing countries, MFIs are tasked to fill certain gaps in the financial sector by granting credit access to the underserved segment of society, and ultimately reduce poverty and enhance the sustainability of these underprivileged regions. However, in order to be able to fulfil this function, they should also be financially self-sustainable. Indeed, MFIs shifted their focus recently from their main social objective towards commercialization and more market-based financial services (Sriram, 2010; Rauf and Mahamood, 2009).

While the European Microfinance Market (EMM) has been growing at an unprecedented rate, experiencing more than 400% increase in loan disbursement and more than a 200% increase in total loan volume since 2009, it is still relatively new when compared to other regional markets, such as Africa and Asia. Despite this, according to Bendig, Unterberg and Sarpong (2014), MFIs operating within the EU are still financially sustainable at least for the short-term, due to declining trends in operating expenses and credit at risk. However, the same study found that many MFIs were struggling to find long-term funding, since many of them were still relatively small and in their early phases of business (Bendig, Unterberg and Sarpong, 2014). Since we were unable to find studies which use Data Envelopment Analysis (DEA) and Malmquist Productivity (MPI) together in order to assess the efficiency of MFIs in terms of changes of different efficiency and productivity scores in the EU region, our objective was to fill this gap by studying the efficiency and productivity changes of MFIs in the EU region during the period of 2013-2017.

The objective was to use a non-parametric approach, such as the DEA, and by using the Index MPI, we were able to examine different productivity and efficiency changes of MFIs that occurred during the sampling period by decomposing several significant components. These included technical efficiency, technological efficiency, pure efficiency and scale efficiency.

2. Research Questions

Are microfinance institutions (MFIs) operating in the European Union efficient enough to be sustainable under the dual objective approach?

In general, MFIs need to generate profit, but at the same time, they are required to balance the social objectives of reaching low-income entrepreneurs while generating a return for their investors (Otero, 1998). Hence, they are often challenged to meet a

"double bottom-line", where they are trying to (i) increase the extent of their outreach, while also (ii) be financially sustainable by covering their operating costs (Azad *et al.,* 2015; Bassem, 2012).

It is important to have a balance between these two goals, as focusing too heavily on either one could spell disaster for such institutions. While overly leaning on their primary social objective can result in the bankruptcy of these institutions, relying too much on only providing their services to low-income earners will also lead to unsustainability in the foreseeable future.

To be able to perform these dual objectives successfully in the long run, MFIs need to be efficient enough in order to improve cost effectiveness and productivity performances. This is where the need for efficiency and productivity analyses arises, in order to examine how MFIs or any institution can improve their outreach performance, remain competitive and become sustainable.

3. Literature Review

3.1 Evolution of Microfinance

Microfinance is considered as an essential part of a developing country's economy and its sustainability outlook. The term and idea behind microfinance was firstly coined and developed in the 1970s by Bangladeshi social entrepreneur, Muhammad Yunus. His work and constant involvement with Grameen Bank[4] helped to alleviate poverty in Bangladesh by lending small amounts of money to the impoverished and financially excluded individuals without requiring any type collateral (Sultan *et al.,* 2017). However, as described by Robinson (2001), microfinance had been practiced by many cultures long before Yunus in the 1970s, such as the "susus" in Ghana, the "cheetu" in Sri Lanka, and the "chit funds" in India.

Today, many MFIs do not only offer small amounts of credit (microcredit) but also a wider array of other services, such as microsavings, microinsurance, pension funds, payment services and scholarships (Tahir and Tahrim, 2015). In a report published by Convergences[5] in 2017, MFIs have reached an estimated 139 million low-income and underserved clients, with loans totaling an estimated $114 billion. These numbers have been mainly supported by the constantly expanding ways of reaching new customers, such as through mobile banking. However, as stated by the report, client outreach has somewhat slowed down in the past five years.

[4]*Grameen Bank (GB) provides microfinance services for people in rural regions so they can use the capital for productive work and become financially stable and independent (see: Sultan et al., 2017).*

[5] ***Source:*** *http://www.convergences.org/wp-content/uploads/2018/09/BMF_2018_EN_VFINALE.pdf*

3.2 History of Microfinance in Europe

EU policymakers have long recognized microfinance services to be an effective tool against social exclusion and an instrument that enhances competitiveness and entrepreneurship. Indeed, the union has implemented a wide array of programs and initiatives over the years in an effort to promote microfinance services.

Starting in late 2007, the European Commission (EC) revealed new Eurostat data which showed that the demand for microfinance services was not being met, and recognized that support for this type of services, such as seed capital and technical assistance for non-bank MFIs, was lacking throughout the member states (EC, 2007). This situation only worsened in the 2007-2008 financial crisis, as many MFIs found themselves struggling to keep up with providing credit to individuals who had suddenly found themselves unable to access credit from more conventional banking means. As a response to this, the EU proposed four main objectives in an effort to curb the obstacles to obtain microcredit and other microfinance services:

- Improving the legal and institutional environment in the member states;
- Further changing the climate in favour of entrepreneurship;
- Promoting the spread of best practices, including training;
- Providing additional financial capital for micro-credit institutions.

EU policy makers launched three main initiatives in order to achieve such goals in the 2007-2013 programming period. Through the Competitiveness and Innovation Framework Programme (CIP), the European Investment Fund (EIF), on behalf of the EC, implemented an SME guarantee facility. This allowed for both bank and non-banks MFIs, such as the Spanish MicroBank and the French ADIE organisation, to supply more debt finance to SMEs by reducing their exposure to risk. Another scheme devised by EC with the support of the EIF was JEREMIE (Joint European Resources for Micro and Medium Enterprises).

This initiative supported the creation and expansion of SMEs by pooling together financial contributions from the European Regional Development Fund (ERDF) and the European Social Fund (ESF) with loan capital and other sources of finance (EC, 2007). Finally, the EC launched JASMINE (Joint Action to Support Micro-Finance Institutions in Europe) which aimed at developing services which focused on improving the quality of microcredit providers in order to support non-bank MFIs[6].

The EIF also launched the European Progress Microfinance Facility in 2010 and started managing it between the 2007-2013 programming period. The facility, which was also funded by the ECB and EC, aimed mainly at supporting targeted eligible

[6] ***Source:*** *https://ec.europa.eu/regional_policy/index.cfm/en/funding/special-support-instruments/jasmine/#1*

intermediaries[7] to enhance their capacity to provide micro-credits by (i) issuing guarantees in order to share the providers' potential risk of loss and (ii) providing funding to increase microcredit lending (Bruhn-Leon, Eriksson and Kraemer-Eis, 2012) (European Council (2007)).

This facility was also included in the 2014-2020 programme for Employment and Social Innovation (EaSI), which is a financing instrument managed directly by the EC, in order to support individuals who desire to start or expand their own business, as well as people who have difficulties in entering the job market or accessing conventional credit markets. Under the EaSI programme, the EC does not finance micro-entrepreneurs or SMEs directly, but rather enables a risk-sharing mechanism between the financial intermediaries and the commission, in order to expand the range of enterprises they can finance. Through this mechanism, the EU can provide €96 million in guarantees throughout this programming period, of which €500 million in loans can be mobilised in order to promote further economic growth and jobs (European Council, 2007)[8].

3.3 Characteristics of European MFIs

Microfinance in Europe is most commonly seen as a tool for the economic growth and social cohesion of many small businesses and families who lack access to more common types of financial services. Such services have a slightly different role in developed countries, such as in European member states. Here, a densely packed number of financial intermediaries and businesses quickly have resulted in a highly saturated market that slows down the progression of their services (Canale, 2010). For instance, high personnel and administrative costs tend to increase the overall cost of delivery of such services. Furthermore, financial sustainability of MFIs tends to be hindered by interest rate ceilings, which limit the possibility of offering small collateral-free loans (Lorenzi, 2016).

According to Eurostat data (2019), the most common type of non-financially related business in the EU region in 2016 were SMEs[9], some 24.4 million, of which 23 million were micro-enterprises[10]. Furthermore, in the EU non-financial business economy, SMEs accounted for about 44.6% of the €7.1 billion value generated in 2016. For that reason, it is essential for the banking system, as a whole, to reach out and support SMEs in order to achieve general socioeconomic improvement in the EU. However, banking and, consequently, lending exclusion in such a region is

[7] *These may include individuals who are: at risk of losing their job, having difficulties re-entering the labour market, and those who are vulnerable enough that they cannot access any conventional credit market.*
[8] ***Source:*** *European Union (2013) "European Union Programme for Employment and Social Innovation ("EaSI"), Regulation No. 1296/2013 of the European Parliament and of the Council.*
[9] *SMEs are usually characterised by having fewer than 250 employees (**source:** Eurostat).*
[10] *Having fewer than 10 employees (**source:** Eurostat).*

common and regularly constitutes a major obstacle in launching new business activities. Microfinance could be a solution for the development and support of such enterprises (Lorenzi, 2016).

In the EU, microfinance services are usually based on microcredit, which are loans of up to €25,000 (Lorenzi, 2016). According to studies conducted by Kraemer-Eis and Conforti (2009, 2013), the EMM is still in its youth and is still quite fragmented, characterised by few granted microloans, limited amounts of personnel employed, and member states with opposing regulatory frameworks. Being composed of different microfinance structures, the EMM has several actors with differing roles, legal forms, target clients, and products being offered, as seen in Table 1.

A study conducted by Bendig, Unterberg and Sarpong (2014), which included 150 institutions from 24 European countries, found that the most common type of MFI were non-banking financial institutions with 29% market share. The second most common type were NGOs/foundations with 23% of the market, followed by credit unions and co-operatives representing 10% of the market. Finally, there were commercial banks which only had 5% of the market.

Similarly to what happened in many other regions, several European institutions in the 1990s transformed into a more formal version of themselves in order to be able to enhance their client outreach by increasing their access to on-lend client savings (Kraemer-Eis and Conforti, 2009). Indeed, a recent study[11] commissioned by the EMN and MFC found that the EMM was gradually addressing the needs of self-employed individuals and existing microenterprises that were still excluded from traditional banking services. As Figure 1 demonstrates, between 2015 and 2017 there was an uptrend in both the number and value of microloans distributed. Furthermore, during this time period, the number of active borrowers rose by 25% to 993,182; and the gross microloan portfolio outstanding rose by 21% to € 3.16 billion.

Table 1. *Characteristics of MFIs in Europe*

Type of MFI	Role of Microfinance	Legal Form	Target Clients	Main Products
Small/Mid-Sized MFIs	Main part of the business's model; usually complemented by SME lending	Private Limited	Micro-enterprises	Commercially priced micro-loans

[11] *Out of the 157 MFIs surveyed from 28 European countries from 2015-2017.*

Bank MFIs	Only a small part of it is devoted to microfinance	Private Limited	Individuals and/or micro-enterprises	Soft-priced/Commercially priced micro-loans
Public Institutions	Varies	Government Agency	Individuals and/or micro-enterprises	Soft-priced micro-loans
Start-up MFIs[12]	Main part of their business model	Private Limited	Varies	Soft-priced/Commercially priced micro-loans
Funds/Vehicles[13]	Main part of their business model	Private Limited	Allows access to intermediaries which otherwise could not be included in the fund	Varies, depending on business model of intermediaries pooled in the indirect Investment

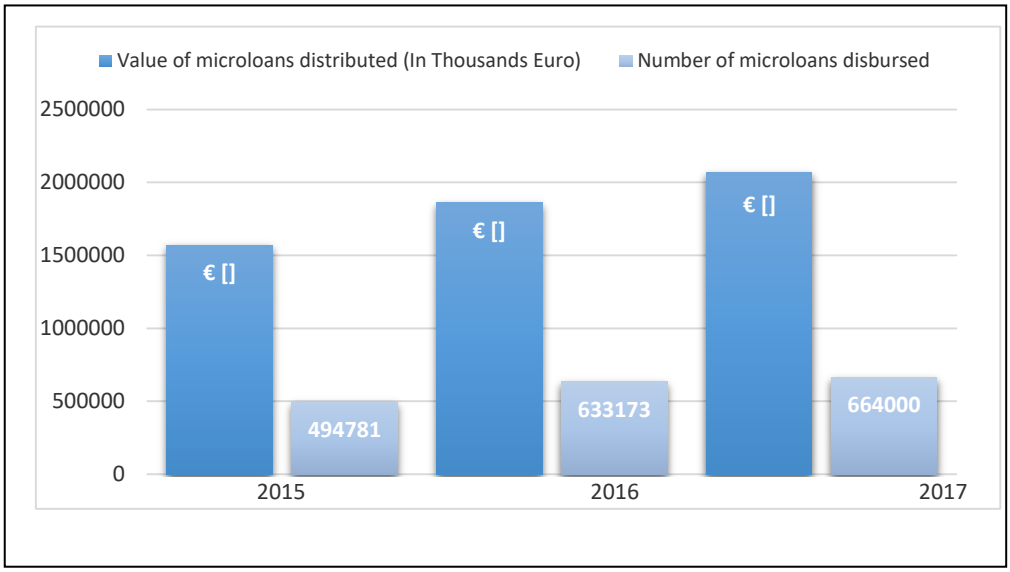
Source: *Adapted from Bruhn-Leon, Eriksson and Kraemer-Eis (2012).*

During this period, MFIs supported entrepreneurs and SMEs mainly by loans that were less than €25,000, followed by personal microloans, and larger business loans of more than €25,000. Additionally, around 70% of MFIs were found to offer also other types of non-financial support to their clients, such as one-on-one coaching, consulting, mentoring or in-group sessions. These services have slowly become a crucial and distinctive part of the European landscape (Converges - Microfinance Barometer, 2018).

Some striking differences can also be seen between the western and eastern European blocs. As microfinance was introduced in the eastern member states after the fall of the communist regime, it was initially pushed by private investors, and has since evolved into a more commercially viable model, driven by profits from higher interest rates and consumer credit. On the other hand, microfinance in member states situated in western Europe is considered as a much newer service[14]; and is also very dependent upon public and private subsidies.

[12] Generally, with little or no track record, and sponsored by private individuals or other investors.
[13] Usually set up by small/mid-sized MFIs for a limited amount of time.
[14] With the exception of France.

Figure 1. *Trends in Microlending activity and outreach between 2015-2017 2017*



Source: *Adapted from Converges - Microfinance Barometer 2018*

3.4 Sustainability of MFIs in Europe

MFIs can be declared as self-sustainable if they can profitably provide services on a continuous basis to the impoverished to a reasonable extent without ever needing to use any outside endowments such as grants and subsidies (Pissarides and Vallanti, 2004). According to various studies (Kar and Deb, 2017; Kinde, 2012; Schäfer & Fukasawa, 2011; Wafula, 2016), there are two main observable ways of determining the level of sustainability of MFIs: Operational Self-Sustainability (OSS) and Financial Self-Sustainability (FSS).

OSS specifies whether an MFI has been earning enough revenue to cover its basic direct costs, while excluding the cost of capital. On the other hand, FSS shows the actual financial health of MFIs by including the adjusted cost of capital on top of the components of the OSS. According to Olivares-Polanco (2005), the sustainability of MFIs can also be measured through the institutions' financial indicators, such as Return on Equity (ROE) and Return on Assets (ROA). According to Mix Market[15], ROE and ROA can be calculated respectively as:

$$\text{ROE} = \frac{\text{Net operating income} - \text{Income Taxes}}{\text{Average total equity}} \text{ x } 100$$

$$\text{ROA} = \frac{\text{Net operating income} - \text{Income Taxes}}{\text{Average total asset}} \text{ x } 100$$

[15] ***Source:*** *https://www.themix.org/mixmarket*

According to an EMN-MFC survey (2016)[16], the average ROE of MFIs in Europe increased from 2.8% in 2014 to 5.7% in 2015; mainly driven by MFIs from the Eastern Bloc – which experienced an increase in ROE from 3.6% in 2014 to 7.7% in 2015. Despite this upsurge, the ROE of MFIs from the Western Bloc actually declined from -0.4% in 2014 to -2.7% in 2015. Furthermore, of the 98 MFIs analysed, 43 achieved OSS, of which only 7 were in western Europe, while the other 36 were in eastern Europe.

3.5 Productivity and Efficiency of MFIs

Overview of Productivity and Efficiency:
The terms efficiency and productivity are often discussed in the context of MFIs and are often used interchangeably. However, according to Sumanth (1998, cited by Uddin, 2015) they are not the same thing: an improvement in efficiency does not necessarily guarantee an improvement in the productivity of an institution. Consequently, while efficiency is measured as a ratio between the actual output generated to its standard output, productivity is measured as the output produced per unit of input consumed, as illustrated respectively below:

$$\text{Efficiency Ratio} = \frac{\text{Actual Output}}{\text{Standard Output}}$$

$$\text{Productivity Ratio} = \frac{\text{Actual Output}}{\text{Inputs Consumed}}$$

Productivity trends are defined by the changes of the productivity level over a period of time which can be best described by an index, as this can easily demonstrate the changes in inputs, outputs and productivity rates on the same graph (Kirikal, 2005). Changes in productivity can either be output-oriented or input-oriented. Output-oriented productivity indices measure the additional output produced, given a certain level of inputs and the present state of technology.

On the other hand, input-oriented productivity indices measure changes in productivity by examining the reduction in input use, which is feasible given the need to produce a given level of output under a reference technology (Coelli, Rao and Battase, 1998). As argued by Kirikal (2005), there are two main approaches to the measurement of productivity change: the econometric approach on one hand, and on the other by constructing indices which use non-parametric methods.

For the purpose of this study, the construction of an index through a non-parametric approach was adopted, due to the fact that it does not necessitate a functional form on the structure of production technology as required by the econometric approach.

[16] ***Source:*** *https://www.european-microfinance.org/sites/default/files/document/file/Survey_EMN-MFC_2014-2015.pdf*

Productivity Indices:

In literature, there are three main alternative methods of constructing an index in order to measure productivity changes. These are the Törnqvist index, the Fisher index, and the Malmquist index (Sufian and Haron, 2008). The Törnqvist index, originally developed at the Bank of Finland in the 1930s, is a changing-weight index which makes use of logarithms in order to compare two entities, or a variable pertaining to the same entity, in two particular time periods (Dean, Harper & Sherwood, 1996). As reported by Caves, Christensen and Diewert (1982), the Törnqvist index has been favoured by many academics in measuring productivity and its consequent analysis, primarily due to the index's consistency for a translog production function. This means that output is specifically presented as an exponential function of the input's logarithms, resulting in fewer restrictions being imposed on both outputs and inputs. Furthermore, unlike other production functions, the translog function allows for the elasticities of substitution among inputs to vary as input proportions vary (Christensen, Jorgenson & Lau, 1973).

Another index used in aggregating finely defined inputs is the Fisher Index. Although used far less than the Törnqvist index, it still performs relatively well in both theoretical and test properties. It is also quite capable in handling zero quantities in its data sets and satisfies additional factor-reversal tests (Diewert, 1992).

Finally, the Malmquist index, which was first introduced by Swedish economist Sten Malmquist in 1953, is a quantity index represented by ratios of distance functions. In 1982, Caves *et al.* (1982) used this index by evaluating the radical distance of both output and input vectors for two particular time periods, in terms of a referred technology, giving rise to the Malmquist Productivity Index (MPI). On the other hand, Färe et al. (1989) calculated the index in a more direct form by exploiting the fact that the distance functions on which the index is based can be calculated by exploiting their relationship to the technical-efficiency measures developed earlier by Farrell (1957). Färe *et al.* (1989) later made use of the connection between the MPI by Caves et al. (1982) and Farell's measures of technical-efficiency in order to introduce a DEAP technique (University of Queensland, School of Economics, n.d.)[17] estimation for the MPI (Kaur and Aggarwal, 2016).

As noted by Grifell-Tatje and Lovell (1997), the MPI is more commonly used in measuring efficiency relative to the Fischer and Törnqvist indices due to a number of benefits. First and foremost, it does not require an assumption about profit maximization or cost minimization. Furthermore, it does not require information on the input and output prices. Also, if the researcher has panel data, it allows the decomposition of productivity changes into two components – technological and technical efficiency. However, it has the drawback of having to compute distance

[17] *Developed originally by Charnes et al. (1978).*

functions, which can nevertheless be mitigated by using a DEAP technique. The inner workings of the MPI and the DEAP are explained in further detail later in the Methodology section (University of Queensland, School of Economics, n.d.).

Input- and Output-oriented Approaches:
The level of efficiency of MFIs – or any other institution for that matter – depends highly on the specifications chosen, evidenced by the research on the selection of input and output vectors (Gutiérrez-Nieto *et al.,* 2007). According to several studies (Athanassoupoulos and Shale, 1997; Bassem, 2008; Berger *et al.*, 1997; Copestake, 2007; Haq *et al.,* 2010), there are two main approaches of choosing input and output vectors, namely, the production approach and the intermediation approach.

In the production approach, only physical inputs and their costs are considered, such as labour and capital, whereby its first objective is to reach the poor. In this case, financial institutions are considered to be the producers of both deposits and loans. The number of employees, physical capital and other operating/administrative costs can be used as input vectors, while the number of opened accounts or processed transactions can be used as output vectors.

Under the intermediation approach, the input of funds and their interest cost are also included, due to the fact that raw materials are transformed throughout the financial intermediation process. The volume of loans and deposits collected can be used as input vectors while loans and investments can be used as output vectors (Gebremichael and Rani, 2012). More approaches have been recently developed, such as that of social efficiency conducted by Bassem (2014). This is based on the approach by Sanchez-Robles (1997), which defines MFI efficiency according to how they gain rather than how well they manage their resources.

Prior research on the efficiency and productivity changes of MFIs:
Although there are several studies which focus on the efficiency and productivity changes of formal financial institutions, such as banks (Berg, et al. 1991), (Mlima, 1999), (Isik and Hassan, 2002a and b) and (Casu, et al., 2004)[18],literature on the efficiency and productivity changes of MFIs is somewhat lacking, especially in the EU region.

One of the first instances when MFIs' productivity changes were specifically investigated was by Gebremichael and Rani (2012). They found that the main source of total factor productivity growth in Ethiopian MFIs was due to technical efficiency changes, with only a few MFIs showing that they had improved due to technological change. The study also showed that Ethiopian MFIs had experienced an increment of pure technical efficiency (improvement in management practices) rather than an improvement in optimum size (scale efficiency change). Similarly, Bibi and Ahmad

[18] *See: Berg, Forsund, Jansen (1991); Mlima (1999); Isik and Hassan (2002); Casu, Girardone and Molyneux (2004).*

(2015) found that the driving force behind the total factor productivity of MFIs in the SAARC region was technical efficiency change rather than technological change, as shown by the lack in innovation in the region. Additionally, there was a larger change in pure technical efficiency (change in administration hones) compared to scale efficiency (change in ideal size).

In another instance, by using a DEA approach, Tahir and Tahrim (2015), found that the overall efficiency of Cambodian MFIs increased. They reported that efficiency was more scale-related than pure technically related. Additionally, the authors suggested that technological change had a large impact on the increase of productivity growth. By decomposing the MPI, Bassem (2014) found that during 2006-2011 period, MFIs in the Middle East and North Africa (MENA) region only experienced a small increment of pure technical efficiency due to the improvement in management practices, rather than in optimum size. Additionally, it was found that a decline in technological change was the main culprit behind the deterioration in the performance of MFIs in this region.

By comparing the analysis of using uncontrollable and controllable variables as inputs in the Africa, Asia, and Latin America regions, Haq *et al.* (2010) found that the production approach was the most efficient with regards to non-governmental MFIs, while the intermediation approach was the most efficient in measuring bank-MFIs. The authors concluded that it may be possible that bank-MFIs may outperform the non-governmental microfinance institutions in the long run. By outlining some key differences under CRS and VRS assumptions, Ahmad (2011) shows that Pakistani MFIs experienced a slow decline in efficiency, which was mainly technical in nature. The author attributed this decline to the lack of management skills and technology as a whole.

4. Methodology

To carry out our analysis, we used a DEA-type MPI and a combination of inputs and outputs as proxies.

Malmquist Productivity Index (MPI):

The MPI is considered to be one of the most valuable tools in production economics for measuring the productivity changes of a set of DMUs across different time periods (Aparicio *et al.*, 2017; Casu *et al.*, 2006). By following the methodology proposed by Fare *et al.*, (1989, cited by Azad *et al.*, 2015; Tahir and Tahrim, 2015) and outlined in the previous section, this study adopted a non-parametric framework through a DEAP (University of Queensland, School of Economics, n.d.) to calculate the output-oriented MPI. First, one needs to denote the input and output vectors of a production unit by X^t and Y^t respectively, where (t) stands for time period. The output set of the production process can therefore be defined as:

$$\mathbf{P^t(X^t) = Y^t} \tag{1}$$

This signifies that X^t produces Y^t, which satisfies the notion of disposability of inputs and outputs (Coelli et al., 2005). A distance function which measures how many units of outputs can be proportionately increased, given the observed level of its inputs, can then be set up as such:

$$D^t\left(x_j^t, y_j^t\right) = min\ (\phi : (y_j^t/\phi)\ \in\ P^t(x_j^t)) \tag{2}$$

Whereby ϕ refers for a radial factor for adjusting an output vector's position. Equation (2) measures the output-oriented technical efficiency of a MFI (j) at time t relative to technology at time t. Given that technical efficiency is measured relative to contemporaneous technology, unit j will be on the production frontier and will be technically efficient if $D^t\left(x_j^t, y_j^t\right) = 1$, but will not be on the production frontier and will not be technically efficient if $D^t\left(x_j^t, y_j^t\right) < 1$.

Before continuing with the MPI methodology, we need to define the output distance functions with respect to two different time periods. The efficiency of unit j at time t, relative to the technology at time t+1, can be represented by:

$$D^{t+1}\left(x_j^t, y_j^t\right) = min\ (\phi : (y^t/\phi)\ \in\ P^{t+1}(x^t)) \tag{3}$$

Similarly, the efficiency of unit j at time t+1 relative to the technology at time t is defined by the distance function:

$$D^t\left(x_j^{t+1}, y_j^{t+1}\right) = min\ (\phi : (y^{t+1}/\phi)\ \in\ P^t(x^{t+1})) \tag{4}$$

Considering the two time frames, t and t+1, and combining the two distance functions in (4-3) and (4-4), we can show the MPI as being equal to:

$$MPI\left(x_j^t, y_j^t\ x_j^{t+1}, y_j^{t+1}\right) = \left[\frac{D^t\left(x_j^{t+1}, y_j^{t+1}\right)}{D^t\left(x_j^t, y_j^t\right)} \mathrm{x} \frac{D^{t+1}\left(x_j^{t+1}, y_j^{t+1}\right)}{D^{t+1}\left(x_j^t, y_j^t\right)}\right]^{\frac{1}{2}} \tag{5}$$

Equation (4-5) shows that the MPI can also be defined as the product of catch-up and frontier-shift terms. A catch-up term $\left[\frac{D^t\left(x_j^{t+1}, y_j^{t+1}\right)}{D^t\left(x_j^t, y_j^t\right)}\right]$ refers to the degree in which a DMU either improves or worsens efficiency, while frontier shift term $\left[\frac{D^{t+1}\left(x_j^{t+1}, y_j^{t+1}\right)}{D^{t+1}\left(x_j^t, y_j^t\right)}\right]$ is a term which reflects the change in the efficiency frontiers between the two time periods (Cooper *et al.*, 2007).
Equation (5) can then be further transformed into:

$$\mathbf{MPI\ (TFP)} = \left[\frac{D^{t+1}\left(x_j^{t+1}, y_j^{t+1}\right)}{D^t\left(x_j^t, y_j^t\right)}\right] \mathbf{x} \left[\frac{D^t\left(x_j^{t+1}, y_j^{t+1}\right)}{D^{t+1}\left(x_j^{t+1}, y_j^{t+1}\right)} \mathbf{x} \frac{D^t\left(x_j^t, y_j^t\right)}{D^{t+1}\left(x_j^t, y_j^t\right)}\right]^{\frac{1}{2}} \quad (6)$$

Equation (6) shows that the output-oriented MPI can decompose the efficiency of MFIs by measuring their change in total productivity growth. MFIs' productivity changes could be due to either a change in technical efficiency or a change in the technology. Hence, the change in total factor productivity (TFP) is the product of TEC and TEH, which can be respectively shown below as;
Technical efficiency change (TEC):

$$\left[\frac{D^{t+1}\left(x_j^{t+1}, y_j^{t+1}\right)}{D^t\left(x_j^t, y_j^t\right)}\right] \quad (7)$$

Technological efficiency change (TEH):

$$\left[\frac{D^t\left(x_j^{t+1}, y_j^{t+1}\right)}{D^{t+1}\left(x_j^{t+1}, y_j^{t+1}\right)} \mathrm{X} \frac{D^t\left(x_j^t, y_j^t\right)}{D^{t+1}\left(x_j^t, y_j^t\right)}\right]^{\frac{1}{2}} \quad (8)$$

Equation (7) represents the index of technical efficiency change between periods t and t+1, measuring whether unit j moves closer to or farther away from the best practices during that time period. If the value of TEC is greater than 1, then the relative efficiency of unit j is considered to be improving during the time period. Equation (4-8) represents the index of technological efficiency change given by the geometric mean of two ratios. If the value of TEH is greater than 1, then this indicates progress in technology during the time period. Concurrently, a value of the MPI greater, equal, or smaller than 1, indicates that productive growth of a MFI either improved, remained unchanged, or declined, respectively.

By adopting CRS and VRS for the output distance functions (Färe *et al.*, 1989), the TEC can be further decomposed into the following equations:

Pure technical efficiency (PE): $$\left[\frac{D_{VRS}^{t+1}\left(x_j^{t+1}, y_j^{t+1}\right)}{D_{VRS}^t\left(x_j^t, y_j^t\right)}\right] \quad (9)$$

Scale efficiency (SE): $$\left[\frac{D_{CRS}^{t+1}\left(x_j^{t+1}, y_j^{t+1}\right)}{D_{CRS}^t\left(x_j^t, y_j^t\right)} \mathrm{X} \frac{D_{VRS}^t\left(x_j^t, y_j^t\right)}{D_{VRS}^{t+1}\left(x_j^{t+1}, y_j^{t+1}\right)}\right] \quad (10)$$

A PE which has a value greater, equal to or smaller than 1, signifies that the pure change in technical efficiency has increased, remained the same, or decreased, respectively. Similarly, a SE which has a value greater, equal to or smaller than 1, signifies that the change in efficiency due to economics of scales has increased, remained the same, or decreased, respectively.

Selection of sample data:
According to the EMN, there are currently 112 microcredit providers of several structure types[19] in Europe. However, for the purpose of this research, this number was reduced greatly due to the nature of many MFIs in this region. This reason is that data could not be generated from the entire sample population, as some lacked sufficient data during the sampling period, while others were too new to be included in the research analysis. Another reason is because EMN took into account MFIs based in Europe but not necessarily in the EU – the focus of this research study. By using a sample size calculator (Creative Research Systems (n.d.))[20], the author found that the actual sample size needed for this type of research study was equal to 10 (given a confidence level of 95% and a confidence interval of 5%).

Hence, for the purpose of this study, the annual data used was extracted from several third-party sources such as Mix Market, and the respective annual reports of MFIs operating in the EU region spanning from 2013 to 2017. It is important to note that while the chosen MFIs were all based in the EU region, they did not necessarily operate only in this region (for example, Millennium BCP does not only operate in Portugal, but currently also in the United States and Canada) and may have offered services other than microfinance services (for example, Patria Bank also offers asset management services). The data obtained from these sources were then stored in Excel spreadsheets before being entered in the DEAP, which will be explained in detail in the following section (University of Queensland, School of Economics, n.d.).

Data Envelopment Analysis Program (DEAP):
Data Envelopment Analysis Programs (DEAP) (University of Queensland, School of Economics, n.d.)[21] are one of the most commonly used programs that use a linear non-parametric approach in order to find a set of frontier observations for which there are no other DMU that has as much or more of every output or as little or less of every input (Berger *et al.*, 1997). In this study, such a program is suitable for measuring the efficiency of MFIs due to the fact that it enables the usage of multiple

[19]*These microcredit providers may include Microfinance institutions (MFIs), private and public banks, credit unions, and not-for-profit MFIs.*
[20]*Source: https://www.surveysystem.com/sscalc.htm*
[21]*Initially developed by Charnes, Cooper, and Rhodes in 1978, DEA programs could initially be used even when profit and other conventional cost functions depended on unjustifiable optimizing reactions to prices. Hence, such programs would not only be intended for use in the public sector and non-profit settings.*

inputs and outputs. Furthermore, unlike a stochastic frontier approach (SFA), such a program does not require additional assumptions for such businesses' processes (Azad et al., 2015). Following the methodology of Førsund (2001), the DEAP can calculate efficiency measures using the following production possibility set:

$$S = \{(x,y) : \textit{whereby } y \textit{ can be produced by } x\} = \begin{Bmatrix} (\mathbf{x},\mathbf{y}) : \sum_{j=1}^{J} \boldsymbol{\lambda}_j \mathbf{y}_{mj} \geq \mathbf{y}_m \forall \mathbf{m}; \\ \mathbf{x}_n \geq \sum_{j=1}^{J} \boldsymbol{\lambda}_j \mathbf{x}_{nj} \ \forall \mathbf{n}, \boldsymbol{\lambda}_j \geq \mathbf{0} \ \forall \mathbf{j} \end{Bmatrix} \quad (11)$$

In equation (11), x represents the input vector while y represents the output vector. In the second row of the equation, index m represents the type of output used and index n represents the type of input used. Furthermore, J points are introduced, whereby λj (j = 1,2,3,...,J) signifies non-negative weights or the intensity variables defining frontier points. In this study, an output-oriented model was chosen to measure overall efficiency. Equation (12) follows a linear program according to the inverse Farrell radial efficiency measure E2i, for each unit i, of a set of J observations. Hence;

$$\frac{1}{E_{2i}} = Max\ \phi_i : \text{such that;}$$

$$\sum_{j=1}^{J} \lambda_j y_{mj} - \phi_i y_{mi} \geq 0, m = 1,2,3,\dots,M$$

$$x_n - \sum_{j=1}^{J} \lambda_j x_{nj} \geq 0, n = 1,2,3,\dots,N$$

$$\lambda_j \geq 0, j = 1,2,3,\dots,J \quad (12)$$

In equation (4-12), ϕ_i refers to the efficiency of a DMU, while λj refers to the proportion of a certain DMU in relation to the efficiency of another, whereby if it is of a positive value, then they are considered as 'peers'. If the model above adds the following constraint;

$$\sum_{j=1}^{J} \lambda_j = 1 \quad (13)$$

then this will measure both the PE and SE of a DMU, which are outlined in the MPI. For the purpose of this research study, a free version of a DEAP version 2.1 designed by the CEPA[22] was used.

[22] *Source: https://economics.uq.edu.au/cepa/software*.

***Selection of inputs and outputs**:*

In this research study, neither the production nor the intermediation approach was used; instead a mix of the two was employed, since both of these approaches fully ignore the two supposed dual functions of financial institutions – which is needed for the purpose of this study. Hence, the selection of inputs and outputs were based on a dual approach centred around the dual objectives of microcredit finance institutions and which focuses on their outreach and sustainability framework (Gutiérrez-Nieto *et al.,* 2007). Accordingly, the two inputs chosen were the number of employees (X1) and the operating expenses (X2); while the gross loan portfolio (Y1) and the amount of outstanding loans (Y2) were the two outputs. Table 2 below shows the definition and details of the selected inputs and outputs.

Inherent limitations and mitigations:

In the course of the research and analysis of this study, some limitations were encountered. As already stated above, data on MFIs in the EU region during the sample period of 2013-2017 was lacking. However, this limitation was partially minimised by choosing already-established institutions from various EU member states – (1) Belgium, (1) Ireland, (3) Italy, (1) Portugal, (1) Romania, (1) Slovakia, (1) Spain, (1) United Kingdom – that represents the sample in the best manner.

***Table 2.** Details of Inputs and Outputs*

Specification (Model)	Variable	Definition	Unit	Represented Objective	Specification (Model)
Input (X1)	Employees	The number of individuals who are actively employed by an institution.	Number	Social Efficiency	Input
Input (X2)	Operating expenses	Operating expense incurred by the institution during the period.	€	Financial Efficiency	Input

Output (Y1)	Gross loan portfolio	The value outstanding principal due for all outstanding client loans at the end of an institution' s balance sheet.	€	Financial Efficiency	Output
Output (Y2)	Loans outstanding	The value of all loans disbursed to clients that have not been fully repaid.	€	Financial Efficiency	Output

***Source**: Iris (2019).*

5. Results and Discussion

In this section we present the efficiency and productivity changes of MFIs in the EU region measured by the DEA-MPI, which can be either a change in technical efficiency or TEC (MFIs are getting closer to the production frontier over time); or a change in the technology or TEH (the changes in production frontier compared with time). The product of these two components will result in total factor productivity or TFP (Azad et al., 2015). TEC is then further decomposed into changes in pure technical efficiency or PE and scale efficiency or SE. All indices are relative to the previous year and hence the output begins with the year 2014. Therefore, the components of the MPI between 2013 and 2014 took the initial score of 1.000 in 2013. It should also be noted that all the values of the components that were greater than 1 indicate progress in efficiency, and values less than 1 indicate regress in efficiency.

5.1 Descriptive Statistics

Table 3 shows the descriptive statistics of the variables used, which includes their average, standard deviation, maximum and minimum values for the sample of 10 MFIs in the EU during the period 2013-2017. It can be observed from the table that the variables used in this study varied significantly among the sample MFIs due to their diverse sizes and countries of origin. Furthermore, some values which are either extreme (for example, MicroBank and Millennium BCP – since they are banks) or that could not be obtained from their respective annual reports had a definite effect on the results of this present research study. Average gross loan portfolio of the

MFIs almost doubled over the five years, exhibiting at least 10% growth per year. Average amount of outstanding loans overall declined for the MFIs during the sampling period. It peaked in 2016, with a 38% increase from the initial year (2013). Average operating expenses borne by MFIs also declined, whereby from 2013 to 2017 MFIs experienced a decline of 0.15%. The average number of personnel employed by the MFIs was initially slowing down, but then it surged by a small amount in the final year of the study (2017).

5.2 MPI Summary of Annual Means

The MFIs' changes in total factor productivity and the components of the MPI during the sample period are specified in Table 2. Overall, the selected MFIs show that they have improved in terms of TFP by only 4.9% annually on average throughout the sampling period. Similarly, as shown in Table 4, technical efficiency regressed on average by 0.8%, while technological efficiency progressed on average by 5.7%. Pure technical efficiency declined by 8% on average, whilst scale efficiency saw an increase of 7.8% on average.

Table 3. *Descriptive statistics*

Year		***2013***	***2014***	***2015***	***2016***	***2017***
Outputs						
Gross Loan Portfolio	Average	75,107,487	83,187,005	106,043,621	131,975,158	145,247,154
	Std. D	131,660,496	145,855,235	196,211,409	265,844,009	293,873,832
	Max	384,870,000	431,350,000	588,000,000	808,900,000	893,740,000
	Min	214,910	1,177,758	1,202,540	2,488,030	3,057,347
Loans Outstanding	Average	3,254,946	1,919,564	3,839,398	4,507,051	2,295,934
	Std. D	5,346,070	4,645,725	9,626,392	11,135,869	5,204,305
	Max	12,951,000	12,449,000	25,666,000	29,748,000	14,067,000
	Min	29	166	598	1,139	1,151
Inputs:						
Operating Expenses	Average	83,008,885	79,014,108	74,946,394	55,652,009	70,755,471
	Std. D	229,123,972	215,267,753	199,886,427	135,616,947	182,441,346
	Max	733,800,000	690,200,000	642,000,000	438,254,000	587,606,000
	Min	471,393	577,831	386,206	661,937	444,781
Number Employee	Average	1,373	1,300	1,287	1,268	1,273
	Std. D	2,747	2,521	2,442	2,429	2,379
	Max	8,584	7,795	7,459	7,333	7,189
	Min	8	8	9	12	6

Source*: Authors' own calculations.*

As noted further in Figure 2, total factor productivity initially regressed in 2014 by 5%. However, this trend reversed in 2015 due to the change in TFP, reaching its highest in the whole sampling period by 18%. In 2016, productivity of MFIs continued to progress but at a lower rate than the previous year, with an increase of 14.9%. Finally, in 2017 productivity among MFIs was at its lowest at a negative change of 6.2%. Overall, change in TFP regressed by a total of 1.2% on average during the whole sampling period.

Figure 3 illustrates how all of the components of the MPI changed between 2013 and 2017. The change in technical efficiency dipped in 2015 and 2016 by more than half from 2014, and then went on to progress by 5.3% in 2017. When TEC is further decomposed, it can be seen that both the changes in scale and pure efficiency regressed in 2015 and 2016, which explains why TEC declined significantly during these two periods. MFIs then improved in terms of scale efficiency in the last year, resulting in a positive change in technical efficiency. Technological efficiency was also quite volatile during the sampling period, as it more than doubled from 2014 to 2015, and then remained relatively the same during the following the year. However, it took another dip during the final year, resulting in a 10.9% deterioration, which helped total factor productivity during 2017 to decline as it did.

Table 4. *MPI Summary of Annual Means*

Year	*TEC*	*TEH*	*PE*	*SE*	*TFPCH*
2013-14	1.575	0.603	1.189	1.325	0.950
2014-15	0.755	1.563	0.845	0.893	1.180
2015-16	0.772	1.488	0.856	0.903	1.149
2016-17	1.053	0.891	0.835	1.262	0.938
Mean	**0.992**	**1.057**	**0.920**	**1.078**	**1.049**

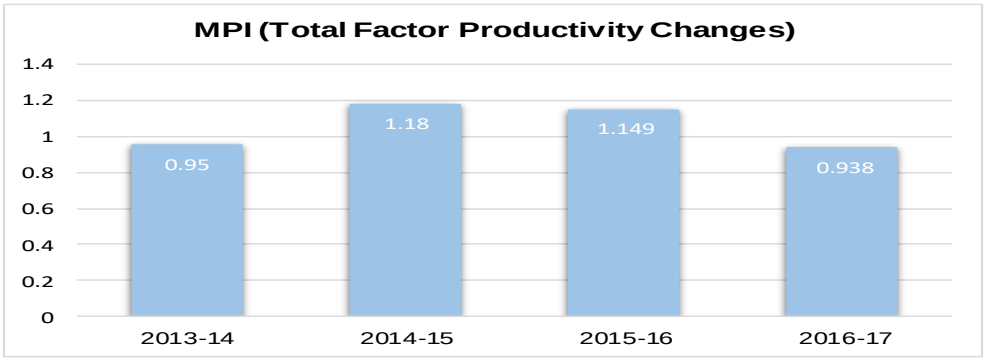
Source: *Author's own calculations.*

5.3 MPI Summary of Firm Means

It can be observed in Table 5 that the main source for the positive change in total factor productivity was technology, which experienced 5.7% progress on average, compared to the 0.8% regression in technical efficiency. This is supported by the fact that only three out of ten MFIs (MicroBank, Cred.it., and Foundation East) showed an improvement or remained unchanged in respect to TEC, while eight of the ten MFIs showed improvement or just remained unchanged in respect to TEH.

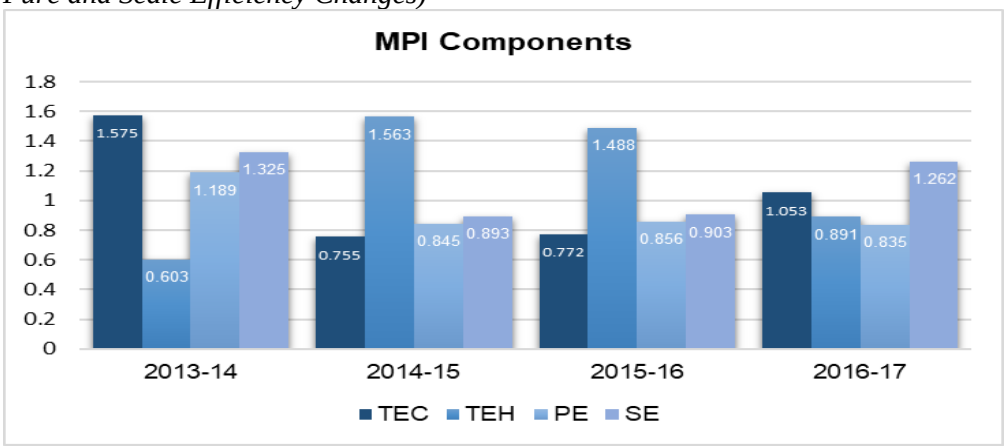
The chosen MFIs in the EU region during the sampling period also seem to have experienced an increase of optimum size (scale efficiency change) with a positive change of 7.8% on average, while also a depletion in management practices (pure technical efficiency) with a negative change of 8% on average.

Figure 2. *MPI (Total Factor Productivity (Changes)*



Source: *Authors' own calculations*

Figure 3. *MPI (Technical Efficiency Changes, Technological Efficiency Changes, Pure and Scale Efficiency Changes)*



Source: *Authors' own calculations.*

5.4 MPI Summary of MFIs

Tables 6, 7, 8 and 9 show the DEA-MPI results for MFIs in the EU region for the sampling period from 2013-2017. The results suggest that the MFIs regressed in total productivity by 5% in 2014 but continued to improve in 2015 and 2016 by 18% and 14.9% respectively. Then, total productivity regressed again by 6.2% in 2017. From Table 6, it can be seen that the sizable upsurge in TEC by 57.5% was not enough to increase TFP in 2014, due to a large decline in TEH which was equal to 39.7%. Further decomposition of TEC shows that both PE and SE increased by 18.9% and 32.5% respectively. As shown in Table 7, in 2015, the advancements in TFP were mainly brought about by a high TEH of 56.3%, while on the other hand, TEC declined by 24.5% from the previous year, due to both PE and SE declining by 15.5% and 10.7% respectively.

A slight decline in TEH in 2016 from the previous year resulted in TFP declining but still showing a positive change equal to 14.9%, as shown in Table 8. TEC also increased slightly during this year, due to higher (but still negative) changes in both PE and SE, which are equal to 14.4% and 9.7% respectively.

Table 9 shows that TFP regressed again to its lowest level in the whole sampling period by 6.2%, mainly due to a reduction in TEH by 10.9%. SE noticeably grew by 26.2% during this year while PE regressed again by 16.5%, resulting in the overall TEC progressing by 5.3%.

Table 5. *MPI Summary of Firm Means*

No.	MFI	*TEC*	*TEH*	*PE*	*SE*	*TFPCH*
1.	**MicroBank**	1.000	1.115	1.000	1.000	1.115
2.	**TatraBank**	0.831	0.850	0.995	0.835	0.706
3.	**Microfinance Ireland**	0.844	1.128	0.661	1.276	0.952
4.	**Millennium BCP**	0.907	1.153	1.000	0.907	1.046
5.	**Alterfin**	0.976	1.159	1.000	0.976	1.132
6.	**Confeserfidi**	0.956	0.746	1.000	0.956	0.713
7.	**Cred.it S.p.A.**	1.757	1.121	0.771	2.279	1.970
8.	**Patria Bank**	0.977	1.105	0.932	1.048	1.079
9.	**PerMicro**	0.904	1.177	0.923	0.979	1.064
10.	**Foundation East**	1.000	1.123	1.000	1.000	1.123
	Mean	**0.992**	**1.057**	**0.920**	**1.078**	**1.049**

Source: *own calculations.*

Table 6 show that MFIs who had very low changes in technological efficiency, such as TatraBank, Confeserfidi and Foundation East, experienced large regressing TFP scores. Furthermore, MFIs who had high TEC, such as Millennium BCP, Credit.it and PerMicro, which were driven by higher scale efficiencies, had quite high productivity changes during 2014.

The results shown in Table 7 indicate that in 2015, MFIs experienced the highest improvement change in TFP, equaling to 18%. This advance in productivity was mainly driven by the fact that most MFIs had positive changes in technological efficiency. Foundation East made the highest progress in productivity when compared to the previous year, due to a large increase in TEH. On the other hand, productivity in MFIs such as PerMicro and Cred.it regressed from the previous year due to a decline in pure technical efficiency and operational scale, respectively.

In 2016, overall total productivity of MFIs continued to progress but to a lesser extent when compared to the previous year, as shown in Table 8. All MFIs during the study period had positive changes in technological efficiency during that year, being led by Alterfin with a 98.8% change. The technical efficiency of most MFIs remained relatively the same compared to the previous year. PerMicro regressed the

most in terms of pure technical efficiency with a 77.4% decline, while TatraBank improved the most with an 84.9% increase. Cred.it, on the other hand, regressed the most in terms of scale efficiency (41.3%).

Table 6. *MPI Summary of MFIs, 2013-14*

No.	MFI	*TEC*	*TEH*	*PE*	*SE*	*TFPCH*
1.	**MicroBank**	1.000	1.099	1.000	1.000	1.099
2.	**TatraBank**	1.869	0.147	1.707	1.095	0.274
3.	**Microfinance Ireland**	0.707	1.163	1.000	0.707	0.822
4.	**Millennium BCP**	2.514	0.421	1.000	2.514	1.059
5.	**Alterfin**	1.032	1.187	1.000	1.032	1.225
6.	**Confeserfidi**	1.000	0.171	1.000	1.000	0.171
7.	**Cred.it S.p.A.**	7.938	1.191	1.000	7.938	9.453
8.	**Patria Bank**	0.969	1.050	0.942	1.028	1.017
9.	**PerMicro**	3.566	0.737	3.502	1.018	2.629
10.	**Foundation East**	1.000	0.430	1.000	1.000	0.430
	Mean	**1.575**	**0.603**	**1.189**	**1.325**	**0.950**

Source: *own calculations.*

As shown in Table 9, six out of the ten MFIs regressed in terms of TFP, with Millennium BCP declining the most by more than 60%, in 2017. This was mainly caused by the fact that all the MFIs experienced a decline in TEH from the previous year. Microfinance Ireland had the largest increase in SE, resulting in its first positive change in TFP during the whole sampling period. It also enjoyed the highest positive change in TFP among the MFIs during this year.

6. Conclusions

The main aim of this study was to determine whether a number of MFIs based in the EU were efficient enough to be sustainable under the dual objective approach – that is, having enough outreach to supply low-income individuals who required credit, while also being financially sustainable.

Findings show that overall total factor productivity declined throughout the sampling period due mainly to a regress in technological efficiency and pure technical efficiency. On the other hand, MFIs experienced a positive change in terms of scale efficiency, meaning that most of them were operating at the right scale of operations, which was reflected in increasing returns to scale. In 2015, MFIs experienced the greatest progression in TFP, made possible by enhanced technological efficiency. This improvement was evident mainly in two banks: TatraBank and Millennium BCP, as well as the UK-based loan agency Foundation East.

Table 7. *MPI Summary of MFIs, 2014-15*

No.	MFI	*TEC*	*TEH*	*PE*	*SE*	*TFPCH*
1.	**MicroBank**	1.000	1.264	1.000	1.000	1.264
2.	**TatraBank**	0.296	2.501	0.404	0.733	0.740
3.	**Microfinance Ireland**	0.400	1.176	1.000	0.400	0.470
4.	**Millennium BCP**	0.860	2.505	1.000	0.860	2.155
5.	**Alterfin**	0.798	1.139	0.950	0.841	0.909
6.	**Confeserfidi**	0.537	1.407	0.572	0.939	0.756
7.	**Cred.it S.p.A.**	1.677	1.130	1.000	1.677	1.894
8.	**Patria Bank**	0.930	1.184	0.849	1.095	1.101
9.	**PerMicro**	0.884	1.748	1.000	0.884	1.545
10.	**Foundation East**	1.000	2.495	1.000	1.000	2.495
	Mean	**0.755**	**1.563**	**0.845**	**0.893**	**1.180**

Source: *Own calculations.*

Table 8. *MPI Summary of MFIs, 2015-16*

No.	MFI	*TEC*	*TEH*	*PE*	*SE*	*TFPCH*
1.	**MicroBank**	1.000	1.147	1.000	1.000	1.147
2.	**TatraBank**	2.056	1.503	1.849	1.112	3.091
3.	**Microfinance Ireland**	0.616	1.274	1.000	0.616	0.785
4.	**Millennium BCP**	0.760	1.861	1.000	0.760	1.415
5.	**Alterfin**	1.253	1.988	1.053	1.190	2.491
6.	**Confeserfidi**	0.630	1.594	0.634	0.994	1.004
7.	**Cred.it S.p.A.**	0.587	1.255	1.000	0.587	0.737
8.	**Patria Bank**	0.817	1.312	0.755	1.082	1.072
9.	**PerMicro**	0.212	1.592	0.226	0.936	0.337
10.	**Foundation East**	0.979	1.569	1.000	0.979	1.536
	Mean	**0.772**	**1.488**	**0.856**	**0.903**	**1.149**

Source: *Own calculations.*

The Romanian Patria Bank was the only MFI which remained consistently efficient throughout the whole sampling period, ranging from its lowest level in 2014 with a 1.7% positive change in TFP, to its highest in 2017 with 12.8%. On the other hand, the worst performing MFI in terms of efficiency and total productivity was the Slovak commercial bank, TatraBank. The bank had its worst year in 2014 when it experienced a negative change in TFP of more than 70%.

It has also been found that MFIs with higher amounts of operating expenses (TatraBank, Millennium BCP) had a tendency of negative changes in scalar

efficiency. On the other hand, MFIs with relatively lower amounts of operating expenses (Microfinance Ireland, Cred.it, Foundation East) experienced positive changes in scalar efficiency. In general, in terms of social efficiency, MFIs with a decreasing number of employees, such as Millennium BCP, were more inclined to have positive changes in total factor productivity. On the other hand, MFIs with an increasing number of employees, such as TatraBank, were more disposed to have negative changes in TFP during the sampling period.

Table 9. *MPI Summary of MFIs, 2016-17*

No.	MFI	*TEC*	*TEH*	*PE*	*SE*	*TFPCH*
1.	**MicroBank**	1.000	0.972	1.000	1.000	0.972
2.	**TatraBank**	0.420	0.945	0.770	0.545	0.396
3.	**Microfinance Ireland**	2.908	0.930	0.191	15.203	2.704
4.	**Millennium BCP**	0.412	0.900	1.000	0.412	0.370
5.	**Alterfin**	0.880	0.672	1.000	0.880	0.591
6.	**Confeserfidi**	2.467	0.808	2.757	0.895	1.993
7.	**Cred.it S.p.A.**	1.220	0.936	0.353	3.454	1.142
8.	**Patria Bank**	1.235	0.913	1.247	0.991	1.128
9.	**PerMicro**	1.002	0.936	0.918	1.092	0.938
10.	**Foundation East**	1.021	0.945	1.000	1.021	0.965
	Mean	**1.053**	**0.891**	**0.835**	**1.262**	**0.938**

Source: *Own calculations.*

MFIs play an indispensable role in reaching entrepreneurs with low income and who do not have access to traditional credit outlets. Additionally, in the context of European MFIs, our findings can also guide government authorities in their provision of subsidies to smaller non-bank MFIs, who are finding it difficult to obtain long-term funding. Also, to the best of our knowledge, there are no studies which use this methodology in order to assess changes in efficiency and productivity scores of MFIs in the EU region.

Overall, as has been established from the data obtained, MFIs need to implement a strategic plan in order to focus more on achieving technological efficiency, which may be either front-end or back-office related. Standardisation may also help MFIs to enhance their outreach and their product by improving their processing systems (Lorenzi, 2016). Furthermore, the level of pure technical efficiency can be raised by many MFIs by improving the allocation of inputs and output factors. Only then can MFIs in the EU region truly meet their dual objectives of improving outreach and being financially sustainable in the long term.

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